REMARKS

The applicant appreciates the Examiner's thorough examination of the application and requests reexamination and reconsideration of the application in view of the preceding amendments and the following remarks.

The Examiner rejects claims 8-10 under 35 U.S.C. §112, second paragraph, as being indefinite. The applicant has cancelled claims 8-10 through the above amendment, which renders this rejection moot. The applicant has also amended claim 70 to include the period at the end of the claim, which was inadvertently omitted. The amendment to claim 70 is not made for reasons related to patentability of the claim.

The applicant's invention, and claim 1 of the subject application in particular, is directed to a rotary seal assembly comprising a first member having a sealing face, a second member having a sealing face with a number of pumping grooves therein, at least a first set of pumping grooves starting proximate a center portion of the sealing face of the second member and extending outward towards the outer diameter of the second member and at least a second set of pumping grooves starting proximate the center portion of the sealing face of the second member and extending inward towards the inner diameter of the second member to direct fluid fed to the center portion of the sealing face simultaneously both inwardly and outwardly from the center portion of the sealing face of the second member to provide a uniform fluid film thickness between the sealing faces of the first and second members when one sealing face cones due to thermal and/or pressure effects, and a feeding groove for providing fluid to the center portion of the sealing face of the second member, the feeding groove being discontinuous forming a number of feeding groove sections.

The Examiner rejects claims 1, 4, 6, 8-9, 13-14, 16, 19-22, 25, 29, 56-60, 65, 68, 70, and 73-74 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,769,604 to *Gardner*. The Examiner states that *Gardner* discloses a stator 106 sealing face which has a first set of pumping grooves 122, a second set of pumping grooves 124, and plural feeding grooves 138 and orifices 140 which provide fluid to the center portion of the sealing face to provide a uniform fluid film during coning.

However, the pumping grooves of *Gardner* do not direct fluid fed to the center portion of the sealing face simultaneously both inwardly and outwardly from the center portion of the sealing face of the second member to provide a uniform firm thickness between the sealing faces of the first and second members as claimed in claim 1 of the subject application. Both sets of pumping grooves 122 and 124 of *Gardner* actually pump inwardly. *Gardner* discloses a fluid drain which communicates with the stator sealing face radially inward of the first set of grooves 122. The fluid drain includes a plurality of arcuate drain pockets 132 with circumferential flow breaks 134 between the drain pockets 132 to ensure that each pocket independently drains fluid from the stator sealing face. Feeding grooves 138 provide a fluid flow only to the second set of grooves 124. See Col. 6, lines 1-33; Col. 7, lines 10-29; and Figs. 2-5 of *Gardner*. Both sets of pumping grooves 122, 124 pump fluid radially inwardly. *Gardner* fails to disclose pumping grooves which direct fluid fed to the center portion of the sealing face simultaneously both inwardly and outwardly from the center as claimed by the applicant.

Accordingly, independent claim 1 and dependent claims 4, 6, 8-9, 13-14, 16, 19-22, 25, and 29 are patentable over *Gardner*. Additionally, independent claim 56 similarly includes the feature of feeding orifices to direct fluid to the inwardly directed pumping

grooves and the outwardly directed pumping grooves simultaneously. As *Gardner* fails to disclose fluid fed to outwardly directed pumping grooves as claimed by the applicant, independent claim 56 and dependent claims 57-60, 65, 68, 70, and 73-74 are also patentable over *Gardner*.

The Examiner also rejects claims 30, 34-38, 41-43, 44-46, and 48-49 under 35 U.C.S. §102(b) as being anticipated by German Patent No. 3,819,566 and claims 30, 34-35, 37-46, and 48-49 under 35 U.C.S. §102(e) as being anticipated by U.S. Patent No. 6,213,473 to *Lebeck*. To advance the prosecution of the subject application, the applicant has amended independent claim 30 to include that the feeding orifices of the first member are positioned in a discontinuous feeding groove in the first member, forming a number of feeding groove sections. As noted by the Examiner at paragraph 12 of the subject Office Action, the '566 patent does not disclose that the feeding groove is discontinuous as claimed by the applicant in amended independent claim 30. The Examiner further notes at paragraph 13 of the subject Office Action that *Lebeck* does not disclose that the feeding groove is discontinuous. As the '566 patent and *Lebeck* both fail to disclose this feature, independent claim 30 and its respective dependent claims are not anticipated by either the '566 patent or *Lebeck*.

The Examiner also rejects claims 47, 50, and 51 under 35 U.C.S. §103(a) as being unpatentable over *Lebeck* and claims 52 and 54 under 35 U.C.S. §103(a) as being unpatentable over *Lebeck* in view of U.S. Patent No. 3,751,045 to *Lindeboom*. As shown above, *Lebeck* fails to disclose all of the features of independent claim 30, including that the feeding groove is discontinuous. *Lindeboom* also fails to disclose a discontinuous feeding groove. Accordingly, dependent claims 47, 50-52, and 54 are patentable over the references for at least the reasons set forth above.

The Examiner rejects claims 30 and 55-75 under 35 U.C.S. §103(a) as being unpatentable over U.S. Patent No. 5,609,342 to *Peterson* in view of *Lebeck*, and claims 76 and 78 over *Peterson* in view of *Lebeck* and further in view of *Lindeboom*. As noted by the Examiner at page 6, lines 21-22 of the subject Office Action, neither *Peterson* nor *Lebeck* disclose that the feeding groove is discontinuous. Amended independent claims 30 and 56 of the subject application include the feature that the feeding groove is discontinuous. Thus, the combination of references fails to disclose all of the elements of independent claims 30 and 56 of the subject application.

The Examiner further alleges that the discontinuous feeding groove is merely a design choice, and thus, it would have been obvious for one of ordinary skill in the art to modify the feeding groove as a matter of design choice. However, the discontinuous feeding groove is not merely a design choice. In order to have a uniform film, the stator not only must conform to the coning of the rotor, it also must conform to the circumferential waviness of the rotor face. The discontinuous feeding groove serves to localize the supply of source fluid so that additional local film stiffness can be generated if the coning and waviness varies circumferentially. This enables the fluid film thickness to be uniformly formed in both radial and circumferential directions. For these reasons, the applicant's discontinuous feeding groove is not merely a design choice.

Accordingly, it would <u>not</u> have been obvious to one of ordinary skill in the art at the time the invention was made to modify *Peterson* to include a discontinuous feeding groove as claimed by the applicant. Therefore, independent claims 30 and 56 and dependent claims 55, 57-76 and 78 are patentable over the references.

The Examiner rejects claims 1, 3-4, 6-17, 19-20, 22-23 and 31-33 under 35 U.S.C. §103(a) as being unpatentable over DE '566 in view of U.S. Patent No. 6,135,458 to *Fuse*. The Examiner states that the '566 patent discloses a seal assembly comprising a stator and rotor, each having a sealing face and two sets of pumping grooves and a feeding groove, but fails to disclose that the feeding groove is discontinuous. The Examiner further states that *Fuse* teaches a sealing assembly using plural feeding grooves to ensure a uniform fluid film across the sealing faces, and that it would have been obvious for one of ordinary skill in the art to modify the feeding groove of DE '566 by making it discontinuous as taught by *Fuse*.

In order to have a uniform film, the stator not only must conform to the coning of the rotor, it also must conform to the circumferential waviness of the rotor face. The discontinuous feeding groove of the present invention serves to localize the supply of source fluid so that additional local film stiffness can be generated if the coning and waviness varies circumferentially. This enables the fluid film thickness to be uniformly formed in both radial and circumferential directions.

However, the applicant submits that it would not have been obvious to modify the '566 patent to include the discontinuous feeding groove of *Fuse*. The '566 patent discloses a gap seal that feeds barrier gas at the ring center to stop fluid exchanging across seal faces. The annular groove in the ring center, stored with higher-pressure barrier gas, acts as a static seal as well when not rotating. See the last paragraph of page 3 of the translation of the '566 patent attached hereto. The '566 patent does not disclose or teach using the groove arrangement to achieve uniform fluid film if one seal member experiences face coning.

> When patentability turns on the question of obviousness, the search for and analysis of the prior art includes evidence relevant to the finding of whether there is a teaching, motivation, or suggestion to select and combine the references relied on as evidence of obviousness. <u>See</u>, <u>e.g.</u>,

McGinley v. Franklin Sports, Inc., 262 F.3d 1339, 1351-52, 60 USPQ2d 1001, 1008 (Fed. Cir. 2001) ("the central question is whether there is reason to combine [the] references," a question of fact drawing on the Graham factors).

"The factual inquiry whether to combine references must be thorough and searching." Id. It must be based on objective evidence of record. This precedent has been reinforced in myriad decisions, and cannot be dispensed with. See, e.g., Brown & Williamson Tobacco Corp. v. Philip Morris Inc., 229 F.3d 1120, 1124-25, 56 USPQ2d 1456, 1459 (Fed. Cir. 2000) ("a showing of a suggestion, teaching, or motivation to combine the prior art references is an 'essential component of an obviousness holding'") (quoting C.R. Bard, Inc., v. M3 Systems, Inc., 157 F.3d 1340, 1352, 48 USPQ2d 1225, 1232 (Fed. Cir. 1998)); In re Dembiczak, 175 F.3d 994, 999, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999) ("Our case law makes clear that the best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references."); In re Dance, 160 F.3d 1339, 1343, 48 USPQ2d 1635, 1637 (Fed. Cir. 1998) (there must be some motivation, suggestion, or teaching of the desirability of making the specific combination that was made by the applicant); In re Fine, 837 F.2d 1071, 1075, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988) ("'teachings of references can be combined only if there is some suggestion or incentive to do so.'") (emphasis in original) (quoting ACS Hosp. Sys., Inc. v. Montefiore Hosp., 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984)).

The need for specificity pervades this authority. See, e.g., In re Kotzab, 217 F.3d 1365, 1371, 55 USPQ2d 1313, 1317 (Fed. Cir. 2000) ("particular findings must be made as to the reason the skilled artisan, with no knowledge of the claimed invention, would have selected these components for combination in the manner claimed"); In re Rouffet, 149 F.3d 1350, 1359, 47 USPQ2d 1453, 1459 (Fed. Cir. 1998) ("even when the level of skill in the art is high, the Board must identify specifically the principle, known to one of ordinary skill, that suggests the claimed combination. In other words, the Board must explain the reasons one of ordinary skill in the art would have been motivated to select the references and to combine them to render the claimed invention obvious."); In re Fritch, 972 F.2d 1260, 1265, 23 USPQ2d 1780, 1783 (Fed. Cir. 1992) (the examiner can satisfy the burden of showing obviousness of the combination "only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references").

In re Sang Su Lee, 277 F. 3d 1338, 61 USPQ2d 1430 (Fed. Cir. 2002).

There is no motivation, teaching or suggestion to modify the feeding groove of the '566 patent to be discontinuous as the '566 feeding groove is specifically disclosed to act as a static seal when not rotating. Further, the '566 patent makes no disclosure, teaching or suggestion to use the annular groove to achieve a uniform fluid firm if a seal member experiences coning.

Accordingly, it would not have been obvious to one of ordinary skill in the art to modify the '566 patent to include a discontinuous feeding groove as taught by *Fuse*. Therefore, claims 1, 3-4, 6-17, 19-20, 22-23 and 31-33 are patentable over the cited references.

The Examiner also rejects claims 1, 3-4, 6, 8-9, 11-25 and 31-32 under 35 U.S.C. §103(a) as being unpatentable over *Lebeck* in view of *Fuse*, and claims 26 and 28 under 35 U.S.C. §103(a) as being unpatentable over *Lebeck* in view of *Fuse* and further in view of *Lindeboom*. The Examiner states that *Lebeck* discloses a seal assembly comprising a stator and rotor, each having a sealing face and two sets of pumping grooves and a feeding groove, but fails to disclose that the feeding groove is discontinuous. The Examiner further states that *Fuse* teaches a sealing assembly using plural feeding grooves to ensure a uniform fluid film across the sealing faces, and that it would have been obvious for one of ordinary skill in the art to modify the feeding groove of *Lebeck* by making it discontinuous as taught by *Fuse*.

The applicant submits that it would not have been obvious to modify *Lebeck* to include the discontinuous feeding groove of *Fuse*. *Lebeck* states that pressurized gas is continually provided to the annular groove 68, and the gas pressure is <u>maintained</u> at a pressure higher than the anticipated process fluid pressure within the pump housing 8. However, the

discontinuous feeding groove of the present invention serves to localize the supply of source fluid so that additional local film stiffness can be generated if the coning and waviness varies circumferentially. *Lebeck* only discloses maintaining the gas pressure in the annular groove and does not disclose, teach or suggest generating additional local film stiffness. Accordingly, there is no motivation, teaching or suggestion in *Lebeck* to modify the annular groove of *Lebeck* by making it discontinuous.

Accordingly, it would not have been obvious to one of ordinary skill in the art to include a discontinuous feeding groove as taught by *Fuse*. Therefore, claims 1, 3-4, 6, 8-9, 11-26, 28 and 31-32 are patentable over the cited references.

CONCLUSION

Each of the Examiner's rejections has been addressed or traversed. Accordingly, it is respectfully submitted that the application is in condition for allowance. Early and favorable action is respectfully requested.

If for any reason this Response is found to be incomplete, or if at any time it appears that a telephone conference with counsel would help advance prosecution, please telephone the undersigned or his associates, collect in Waltham, Massachusetts, at (781) 890-5678.

Respectfully submitted,

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3074 H

Translation of

German Offenlegungsschrift DE 38 19 566 A1

Gap seal

A gap seal for sealing off the interior in a housing from the outside, a rotating shaft with a revolving ring leading into the housing and a sealing gap being formed between said ring and a fixed sealing ring. One of the boundary surfaces of the sealing gap has spiral grooves 18, 19 that leave free a spiral-free dam 23, 24 at the inner and outer edges. Formed in the region of the spiral grooves 18, 19 is an annular groove 20 which can be supplied with barrier gas and feeds it to the spiral grooves. In the annular boundary surface of the sealing gap, the spiral grooves 18, 19 extend from the annular groove 20, viewed in the running direction, both in the region of the annular surface outside the groove 20 and in the annular region enclosed by the groove 20, based on their direction of curvature, in symmetry against the spiral-free edge 23, 24 acting as a dam.

Description

The present invention relates to a gap seal for sealing the interior in a housing from the outside, a rotating shaft leading into the housing, the seal comprising the features in the preamble of patent claim 1.

The known double-action shaft seals which are e.g. used in compressors consist of a plane-parallel ring revolving with the shaft, a fixed sealing ring connected to the housing being opposite to said plane-parallel ring at the front side, separated

by a very thin radial gas film or gap. In the middle of the fixed sealing ring the barrier gas is supplied for generating the gas film from where it flows off radially to the inside and outside. In specific compressors, the shaft seal at the process gas side is supplied with the same gas which is e.g. present as a light additional gas in a conveyance material. In the space between both shaft seals there is a mixing of barrier gas from the shaft seal at the process side and from the shaft seal at the atmospheric side. The gas mixture is then removed from said space and passed to the outside, which means a continuous demand for barrier gas.

The drawback in the known constructions of shaft seals with sealing gaps is the relatively high barrier gas consumption which constitutes a significant cost factor in cases where helium is used as the barrier gas. Moreover, the contamination caused by the barrier gas inflow or the change in concentration of the conveyance material makes it seem desirable to reduce the barrier gas consumption.

Since the barrier gas consumption is proportional to the third power of the gap height, the most efficient possibility of reducing the gas consumption is a decrease in the gap height of the gas film between the fixed sealing ring and the ring revolving with the shaft. Furthermore, it is possible due to the non-symmetrical division of the inflowing barrier gas flow in the gas gap to keep the partial flow flowing into the conveyance chamber (contamination of the conveyance material) and the partial flow flowing towards the atmospheric side (barrier gas loss) as small as possible. Whenever the operational reliability is also to be ensured in the case of a reduced gap height, the following preconditions have to be paid attention to:

The stiffness of the gas film in the sealing gap must be sufficiently high, i.e., a reduction of the gap height due to operation can be counteracted by a sufficiently steep pressure rise in the gas gap over the whole speed range.

Since changes in the gap width due to the operation mainly occur on the inner and outer edges of a gap seal, the radial pressure distribution must have its maximum

at said place. This is accomplished by the inventive arrangement of the spiral grooves. Assemblies in which spiral-like channels, grooves or flat pockets are arranged either in the rotating or in the fixed ring are known as dynamically operating axial bearings and as seals with liquid and gaseous media. Known are also seal constructions with spiral grooves with conveyance from the outer edge to the inside or from the inner edge to the outside against a dam. Furthermore, a symmetrical arrangement of the spiral grooves is known with conveyance from the outer and inner edges towards the center and is used as a gas-lubricated axial bearing.

It is now the object of the present invention to provide a gas-blocked contact-free shaft seal for process pressures below atmospheric pressure that in comparison with the existing shaft seals shows a much lower barrier gas consumption or a smaller barrier gas inflow into the conveyance material. The seal should also operate without contact during activation and deactivation until standstill as has so far been the case.

To achieve said object, the present invention now suggests the features that are listed in the characterizing part of claim 1. Further advantageous designs of the invention become apparent from the features indicated in the characterizing parts of the sub-claims.

The gap seal of the invention combines the advantages of both dynamically operating shaft seals and statically operating shaft seals. In the gap seal of the invention, the spiral-like flat pockets (spiral grooves) which in the fixed ring show symmetrical conveyance to the inside and the outside mainly assume the pressure build-up during operation, the maximum respectively occurring in the edge zones on the inside and outside. The barrier effect is ensured by the gas supply into the concentric flat annular groove arranged in the ring center. During activation and deactivation there is no pressure build-up in the spiral grooves. In this case the barrier gas supply ensures the build-up of a gas cushion in the annular groove and in the spiral groves, i.e. the seal operates in this case as a static seal. Of course,

the spiral grooves and the concentric annular groove may also be provided in the revolving ring instead of the fixed ring. What is novel in the inventive shaft seal is the symmetrical arrangement of the spiral grooves from the ring center with respective conveyance to the outside and to the inside against a dam, each of the spiral grooves extending away from one another. What is also novel is the barrier gas supply via the annular groove in combination with the adjoining spiral grooves. This has the effect that the seal fulfills its barrier function without contact in the case of a rotating shaft and in the case of a stationary shaft. The advantage of the novel shaft seal of the invention over the known constructions is the considerably reduced barrier gas consumption and thus a smaller barrier gas inflow into the process chamber.

Further details of the present invention will now be explained in more detail with reference to the figures, in which

Fig.1 shows a section through the whole assembly of the gap seal, and
Fig. 2 shows section AB in Fig. 1 and a top view on the spiral grooves.

According to Fig. 1 the interior 5 of a housing 6 is to be sealed with respect to the space 7 from which a shaft 1 leads into the housing 6. A process pressure, which may be atmospheric pressure, prevails in the interior 5. A co-rotating revolving ring 2 which has a sealing gap surface 8 perpendicular to the rotational axis is seated on the shaft 1, for instance, of a flow compressor. Opposite to said rotating surface 8 is the bearing surface 9 of a fixed sealing ring 3, sealing gap 4 being formed between surfaces 8 and 9. The fixed sealing ring 3 is pressed by compression springs 10 against the revolving ring 2, the springs 10 being located in bores 13 of an installation ring 11 in which the sealing ring 3 is supported by means of its collar 12 with a play. The springs 10 are supported on a retaining ring 14 which is firmly connected to the housing 6. The installation ring 11 has also installed therein, within collar 12, hardened anti-rotation means in the form of screwed-in studs 15 which engage into further bores 16 in the sealing ring 3 and protect

possibly existing diagnostic means, or the like, from destruction in the case of a frictional contact between fixed sealing ring 3 and rotating revolving ring 2.

A radial sealing ring 17 is positioned between the fixed sealing ring 3 or its collar 12 and the inner surface of the installation ring 11, the radial sealing ring having the following tasks:

Sealing between the process gas and the atmosphere, accommodating the thermal expansion during operation, immediate damping when instabilities arise. A bellows (not shown) may also serve as a bearing element and combines supporting, sealing and spring functions.

Fig. 2 shows a section through the fixed sealing ring 3 from the sealing gap 4 with a view on the grooved front or bearing surface 9 opposite to the rotating revolving ring 2. The revolving ring 2 rotates during operation at a constant circumferential speed and at a defined gap height above the fixed sealing ring 3 which is provided in the bearing surface 9 with spiral grooves 18, 19. To supply the spiral grooves 18, 19 at the input side of the fixed sealing 3 in a uniform way with barrier gas, a flat annular groove 20 is incorporated that is fed by throttles 21. Now, the barrier gas flows radially from the annular groove 20 to the inwardly and outwardly conveying spiral grooves 18 and 19.

The pressure in the barrier gas layer is increased due to the azimuthal gas transportation accumulated at the spiral groove webs 22 which are offset at a right angle, namely by the drag effect of the revolving ring 2.

When the gas conveyance in the spiral grooves 18, 19 is impeded at the end of the spiral grooves in that a spiral-free circular dam follows at the inside 23 and at the outside 24, an additional pressure build-up is superposed on the azimuthal pressure build-up in radial direction. A force balance prevails when the resulting compressive force in the sealing gap corresponds to the compressive forces acting from above, including the spring closing force of springs 10, and a constant

working gap height is observed in the sealing gap 4 between fixed sealing ring 3 and revolving ring 2.

The annular groove 20 feeds the spiral grooves 18 and 19, said grooves extending in symmetry in the annular bearing surface 9 from the annular groove 20, viewed in the running direction 25 of the revolving ring 2, i.e. both in the region of the annular surface outside the annular groove 20 as outer spiral grooves 19 and in the annular region enclosed by the annular groove 20 as inner spiral grooves 20, based on their direction of curvature, each in symmetry against the spiral-free edges 23 and 24 acting as dams. As shown, the annular groove 20 may be arranged together with the spiral grooves 18 and 19 in the same surface 8 or 9, but it may also be positioned, separated therefrom, in the respectively opposite surface.

At standstill and during activation and deactivation (low speed) of a flow compressor belonging e.g. to shaft 1, the gap seal operates in a static way due to the inwardly and outwardly extending spiral grooves 18, 19 at a barrier gas feed pressure that is increased with respect to the operative state. The spiral grooves 18, 19 which are evenly distributed in symmetry, for instance on the fixed sealing ring 3, act as gas pockets.

List of reference numerals:

1	Shaft
2	Revolving ring
3	Sealing ring
4	Sealing gap
5	Interior
6	Housing
7	Space
8	Sealing gap surface
9	Bearing surface

10 Compression springs
11 Installation ring
12 Collar
14 Bores
14 Retaining ring
15 Studs
16 Bores
17 Radial sealing ring
17 Spiral grooves on the inside
19 Spiral grooves on the outside
20 Annular groove
21 Throttles
22 Spiral groove webs
23 Spiral-free dam on the inside
24 Spiral-free dam on the outside
25 Running direction

Patent Claims

1. A gap seal for sealing off the interior in a housing from the outside, a rotating shaft leading into the housing, comprising the following features:

a) a co-rotating revolving ring (2) having a sealing gas surface (8) perpendicular to the rotational axis is seated on the shaft (1);

b) a stationary sealing ring (3) is movably supported on the housing (6) under spring force;

c) the sealing ring (3) is guided in a bearing element (11) belonging to the housing (6);

d) the sealing ring (3) has a bearing surface (9), the annular sealing gap (4) being formed between said bearing surface and the sealing gap surface (8);

e) one of the boundary surfaces (8, 9) of the sealing gap (4) has formed therein spiral grooves (18, 19) which leave free a respective spiral-free dam (23, 24) on the inner and outer edges;

f) the region of the spiral grooves (18, 19) accommodates an annular groove (20) which can be supplied with barrier gas and feeds it to said spiral grooves,

characterized by the further features:

g) in the annular boundary surface (8, 9), the spiral grooves (18, 19) extend from the annular groove (20), viewed in the running direction, both in the region of the annular surface outside the groove (20) and in the annular region enclosed by the groove (20), based on their direction of curvature, in symmetry against the spiral-free edge (23, 24) acting as a dam.

2. The gap seal according to claim 1, characterized by the further feature:

h) the spiral grooves (18, 19) and the annular groove (20) are introduced either jointly or separated from one another into the bearing surface (9) of the sealing ring (3) or the sealing gap surface (8) of the revolving ring (2).

3. The gap seal according to any one of claims 1 or 2, characterized by the further features:

i) the bearing element for the sealing ring (3) consists of an installation ring (11) which is installed in a direction coaxial to the shaft (1) or the sealing ring (3) in the housing (6);

j) the sealing ring (3) engages with a collar-like continuation (12) as a support into a neck of the installation ring (11);

k) stationary bolts (15) are mounted on the installation ring (11) distributed over the circumference, the bolts engaging with a play into bores (18) of the bearing ring (3) as anti-rotation means.